



Biology and morphometrics of root mealybug *Formicococcus polysperes* Williams (Hemiptera: Pseudococcidae) infesting black pepper (*Piper nigrum* Linnaeus)

Najitha Ummer*, SusannammaKurien and Maicykutty P. Mathew

Department of Agricultural Entomology, College of Horticulture, Kerala Agricultural University, Vellanikkara 680656, Kerala, India. Email: najithaummer@gmail.com

ABSTRACT: Studies on the biology of *Formicococcus polysperes* Williams infesting roots of black pepper (*Piper nigrum* Linnaeus) revealed females reproduced ovoviviparously and the reproductive period including pre larviposition, larviposition and postlarviposition periods lasted for an average of 23.65 ± 2.01 , 9.6 ± 3.34 and 4.15 ± 0.93 days respectively. Gravid females gave birth to 136.15 ± 74.93 crawlers. Development period of females included three nymphal instars whereas males had two nymphal instars, a pre pupal and pupal stages. Duration of first two nymphal instars, third female nymphal instar, pre-pupal and pupal stages 8.4 ± 2.46 , 6.35 ± 1.95 , 8.4 ± 1.87 , 1.4 ± 0.50 and 7.15 ± 0.88 days respectively. Adult males were short lived (1.8 ± 0.52 days) and adult females lived for 37.4 ± 3.10 days. Total life cycle of males was shorter (23.7 ± 3.01 days) than that of females (60.55 ± 5.36 days). The sex ratio was 1.00:2.71 (male: female). The morphometric data of all stages are presented.

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KEYWORDS: Root Mealybug, *Formicococcus polysperes*, life cycle, morphometrics, *Piper nigrum*

INTRODUCTION

Mealybugs are important pests of black pepper (Koya *et al.*, 1996) and its infestation on roots of black pepper were reported from different districts of Kerala. Higher infestation was reported in Wayanad (8.0 to 21.1 %) and lower in Idukki (0 to 3%). Stray infestation of the pest was observed in Kozhikode and Kannur districts (Devasahayam *et al.*, 2010). *Planococcus* sp., *P. citri* (Risso), *P. lilacinus* (Ckll.), *Dysmicoccus brevipes* (Ckll.) and *Ferrisia virgata* (Ckll.) were reported to be infesting roots and basal portions of stems (under the soil) of black pepper vines. Colonies of these root mealybugs were distributed on the main,

secondary and tertiary roots and basal region of stems on rooted cuttings in the nursery and also on the vines of all age groups in the field.

Severe infestation resulted in defoliation, yellowing and wilting of leaves and lateral branches and also mortality of vines (Devasahayam *et al.*, 2010). Another hypogean mealybug species, *Formicococcus polysperes* Williams (Homoptera: Pseudococcidae) which is known to infest root region of crops of different families was also observed on the roots of black pepper in Kerala. Williams (2004) described this species from roots of *Macaranga triloba* (Thunberg) Müller Argoviensis from Malaysia and reported its

* Author for correspondence

distribution and host plants. It was reported on roots of *Macaranga triloba*, *M. conifer* (Reichenbach & Zollinger) and *Sapium buccatum* Roxburgh (Euphorbiaceae) from Malaysia, *Zingiber officinale* Roscoe (Zingiberaceae), *Cocos nucifera* L. And *Rhapis excels* (Thunberg) Henry (Aracaceae) from Philippines, *Z. officinale* from Thailand and *Lansium domesticum* Corrêa from Vietnam. In India, it has been reported on roots of *Piper nigrum* L. (Kerala), *P. betle* L. (Madhya Pradesh, Uttar Pradesh, and West Bengal), *Areca catechu* L. (Uttar Pradesh) and on pods of *Arachis hypogaea* L. (Orissa) (Williams, 2004). Detailed biology and morphometrics of *F. polysperes* was undertaken for the first time.

MATERIALS AND METHODS

Studies were undertaken in the laboratory of department of Agricultural Entomology, College of Horticulture, Kerala Agricultural University. The temperature during the study period (February to April 2015) ranged from 29.4°C and 31.7°C and relative humidity was 57 - 82 per cent.

Identification of mealybug species: Root mealybugs were collected from pepper gardens of Wayanad and Idukki districts of Kerala. The collected samples were preserved separately in 70 % ethyl alcohol and sent to National Bureau of Agricultural Insect Resources, Bengaluru for identification.

Laboratory rearing of mealybugs: Mature pumpkin (*Cucurbita moschata* Duch.) fruits with abundant grooves were used as substrate for mass rearing of mealybugs. Fresh pumpkin fruits were washed thoroughly with water, disinfected with 0.1% carbendazim and air dried. Such pumpkins were tied with twine along the grooves for easy establishment of the mealybugs and kept in aluminium netted rearing cages kept at temperature of 27-28°C. Ant pans were maintained to prevent the entry of ants into the cage. The adult mealybugs collected from pepper gardens were released at the stalk region of pumpkin and covered with a steel bowl for 7 days to provide darkness and to restrict the movement of mealybugs so that they settled

easily. The bowl was removed after the mealybugs settled on the pumpkin.

Biology: Cut portions of pepper cuttings (from runner shoots) with at least one leaf node and aerial root was selected as the substrate for the study of biology. Eggs were not observed during the study and hence, one day old first instar nymphs (crawlers) were released near to the leaf node of pepper cuttings using camel hair brush. Nymphs used for the study were taken from single female. The pepper cuttings were kept in Petriplates lined with a layer of wet absorbent cotton and observed daily for recording the number and duration of nymphal instars. Moulting was confirmed by examining the presence of exuviae under stereoscopic microscope and removed after each moult. Twenty replications were maintained. Adult females were kept separately on pepper cuttings to observe pre-larviposition, larviposition and post larviposition periods. Twenty replications were maintained. Adult females were observed daily to record number of crawlers produced. Nymphs produced were removed daily with soft camel hair brush to avoid repeated counting. Nymphs from each female were reared separately and observed till the males and females can be distinguished for determination of sex ratio. The nymphs forming cocoons were separated as males. Adult longevity of females and males were observed separately.

Morphometry: Morphometric data of all stages were measured using stereo zoom microscope (Lieca®) with image analyzer facility. Body length and width of 20 individuals of all stages were measured to determine body size. Length was measured dorso-medially from the head to the tip of the abdomen. Width was measured at the widest part of body.

RESULTS AND DISCUSSION

Pre-larviposition, larviposition and post larviposition periods lasted for an average of 23.65 ± 2.01 , 9.6 ± 3.34 and 4.15 ± 0.93 days, respectively. Adult females of *F. Polysperes* gave birth to first instar nymphs (crawlers) ovoviparously, into a cotton like wax threads secreted from the posterior part

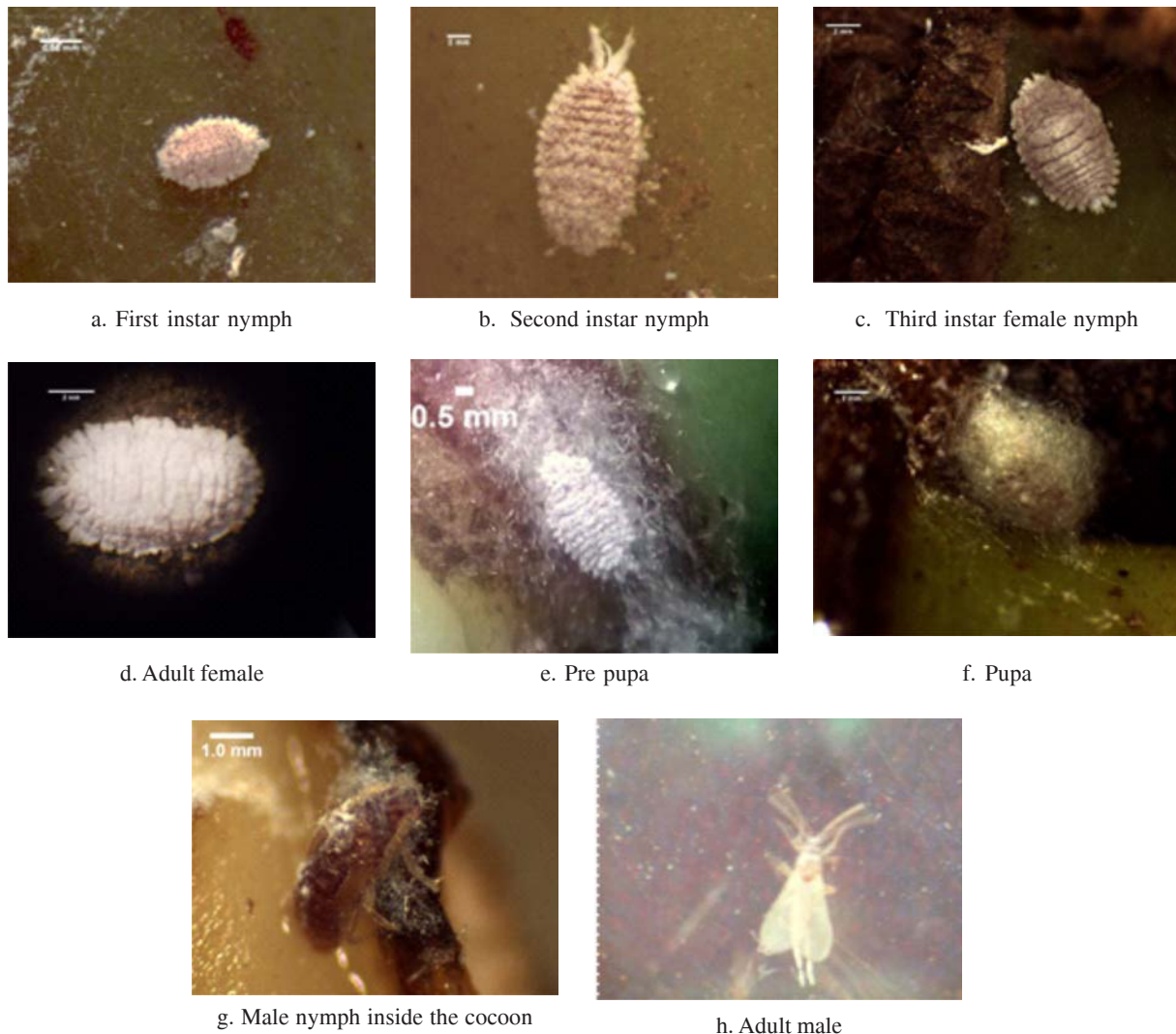


Fig. 1. Life cycle of *Formicococcus polysperes*

of the body. Adult female produced an average of 136.15 ± 74.93 crawlers and sex ratio was 1: 2.71 (male: female). Males and females of *F. polysperes* exhibited variation in its development stages. The female had three nymphal instars while the male had two (Table 1).

First instar: Freshly delivered first instar nymphs were oval, light pink with three pairs of legs and a pair of filiform antennae (Fig. 1a). Body colour changed from pink to pale white within a day after larviposition. Length of first instar nymphs was 0.89 ± 0.09 mm whereas width was 0.51 ± 0.06 mm. Duration of first nymphal instar lasted for 8.4 ± 2.46 days.

Second instar: Both first and second instar nymphs were similar in appearance and morphological characteristics except in body size (Fig. 1b). Wax coating was absent on body and secreted after about 24 hours of moult. Length and width of second instar nymph were 0.89 ± 0.09 mm and 0.51 ± 0.07 mm, respectively. Duration of second instar lasted for 6.35 ± 1.95 days.

Third instar: Males and females could distinguish from third instar onwards. After second instar, fine silken waxy threads were formed by males which was absent in females. Hence, from this stage onwards, the observations were taken separately for males and females.

Table 1. Biology and morphometrics of *Formicococcu spolysperes*

Stage	n	Duration (Days)		Length (mm)		Width (mm)	
		Range	Mean	Range	Mean	Range	Mean
Development period							
First instar nymph	20	6-14	8.4 ± 2.46	0.64 - 0.98	0.89 ± 0.09	0.35 - 0.59	0.51 ± 0.06
Second instar nymph	20	5-10	6.00 ± 1.21	1.02 - 1.69	1.39 ± 0.25	0.56 - 0.99	0.80 ± 0.14
Third instar female nymph	20	6-13	8.4 ± 1.87	1.71 - 2.47	2.10 ± 0.26	0.91 - 1.82	1.25 ± 0.22
Pre-pupa	20	1-2	1.4 ± 0.50	1.01 - 1.62	1.29 ± 0.21	0.55 - 0.86	0.65 ± 0.11
Pupa	20	6 - 9	7.15 ± 0.88	1.56 - 2.41	2.03 ± 0.27	0.49 - 0.92	0.82 ± 0.13
Male	20	1-3	1.8 ± 0.52	0.78 - 1.57	1.13 ± 0.26	0.24 - 0.46	0.33 ± 0.06
Female	20	30 - 41	37.4 ± 3.10	2.1 - 3.25	2.65 ± 0.32	1.3 - 1.94	1.56 ± 0.24
Prelarviposition	20	21-29	23.65 ± 2.01	-	-	-	-
Larviposition	20	4-15	9.6 ± 3.34	-	-	-	-
Post larviposition	20	3-6	4.15 ± 0.93	-	-	-	-
Larviposition	20	76-357	136.15 ± 4.93	-	-	-	-
Total lifecycle							
Male	20	20 - 31	23.7 ± 3.01	-	-	-	-
Female	20	49 - 70	60.55 ± 5.36	-	-	-	-

*n: No. of observations/ replications

Third instar female nymph: Waxy filaments along the body margin were prominently visible from third instar onwards and nymphs were similar to adult females except in body size (Fig. 1c). Length of third instar female nymph was 2.10 ± 0.26 mm whereas width was 1.25 ± 0.22 mm. Duration of third instar was 8.4 ± 1.87 .

Pre-pupa: This stage was identified by the presence of fine waxy threads which was later formed into a cocoon (Fig. 1e). Duration of this instar lasted for an average of 1.4 ± 0.50 days. Morphometrics of pre-pupal instar was similar to that of second instar with length and width of 1.29 ± 0.21 mm and 0.65 ± 0.11 mm, respectively.

Pupa: Male nymphs secreted waxy threads to form cocoon which covers the entire body. Cocoon was cylindrical and exuviae was present outside with which second moulting was confirmed (Fig. 1f). The male nymph inside the cocoon was dark pink in colour, slender, with a pair of 10 segmented

antennae which was directed backwards along body margin and with wing pads. Waxy coating was absent (Fig. 1g). Duration of pupal instar lasted for an average of 7.15 ± 0.88 days. Length and width of male pupa was 2.03 ± 0.27 mm and 0.82 ± 0.13 mm, respectively.

Adult: Females were apterous, soft bodied, oval and pink. Body segmentation was visible with powdery wax secretion. Waxy filaments surrounding the body margin are short and thick (Fig. 1d). The morphometric measurements of adult female was 2.65 ± 0.32 mm length and 1.56 ± 0.24 mm width. Males were slender, delicate, elongated and reddish brown with a pair of well developed, pale white and opaque wings, a pair of long waxy caudal filaments. A pair of long, 10 segmented antennae was also present which was characteristic of male (Fig. 1h). Male measured 1.13 ± 0.26 mm in length and 0.33 ± 0.06 mm width. Males were short lived when compared to females. Longevity of males was 1.8 ± 0.52 days and that of females

was 37.4 ± 3.10 days. Males had shorter life cycle than that of females which was lasted for an average of 23.7 ± 3.01 . Total life cycle of females was an average of 60.55 ± 5.36 .

Bio-ecology, natural enemies and control measures of *F. polysperes* are not reported so far. The only information available on the pest is about its host and distribution by Williams (2004) and its infestation (48.3 %) on ginger in Meghalaya by Firake *et al.* (2015). The present study on the biology and morphometrics of *F. polysperes* provides basic information for the first time which would help to investigate further applied aspects of the pest. Trapeznikova and Gavrilov (2008) supports the ovoviviparous mode of reproduction in *F. polysperes* in which eggs hatch inside the reproductive system of females and deliver the hatched out young ones. Another genus of *Formicococcus*, *F. njalensis* (*Pseudococcus njalensis*) also reproduced ovoviviparously with low fecundity varying from 6 to 90 (Strickland, 1951). Life cycle of female *F. polysperes* was similar to that of *F. njalensis* in with three nymphal instars were reported with average duration of 7, 5 and 7 days respectively for first, second and third nymphal instar. The pre oviposition period recorded in *F. njalensis* was 23 days and is similar to *F. polysperes* in the present study (Strickland, 1951).

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